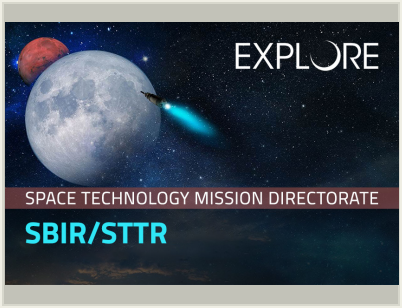
Rapid Manufacturing of Durable, Cost-Effective Ceramic Matrix Composites for High Temperature Structures, Phase I

Completed Technology Project (2015 - 2015)

Project Introduction

Hypersonic vehicles require durable and cost-effective hot structures that do not impose weight penalties such as those associated with the use of non-structural thermal protection systems. In previous work for NASA and DoD, Ultramet demonstrated the fabrication of carbon fiber-reinforced refractory carbide matrix composites for missile and railgun projectile nosetip and aeroshell applications using a rapid, low-cost melt infiltration process. The composite materials underwent extensive high temperature testing under laser and arcjet heating conditions and exhibited low or no erosion when tested to nearly 2900°C. The composites also exhibited extremely high toughness and thermal shock resistance and have good potential for operation in adverse weather. Stability in rain, snow, and hail is a critical issue for hypersonic vehicles, and Ultramet composite materials have performed very well in hydrometeor and nylon bead impact tests conducted by NASA MSFC. In this project, Ultramet will advance the state of the art in melt infiltration processing by developing innovative process improvements to optimize the refractory carbide matrix, resulting in enhanced in-plane and through-thickness mechanical properties for operation over the temperature range from 1500 to 3000°C in the hypersonic vehicle environment. Melt infiltrated carbide matrix composites contain residual unreacted metal within the matrix which provides enhanced toughness but, if excessive, can lead to low elevated temperature mechanical properties. This work will further reduce and optimize the percentage of residual metal in the matrix to produce composites with an optimal balance of toughness/impact resistance and elevated temperature interlaminar and through-thickness mechanical properties. A demonstrator article will be fabricated and subjected to high temperature oxidation testing at the Air Force LHMEL facility.



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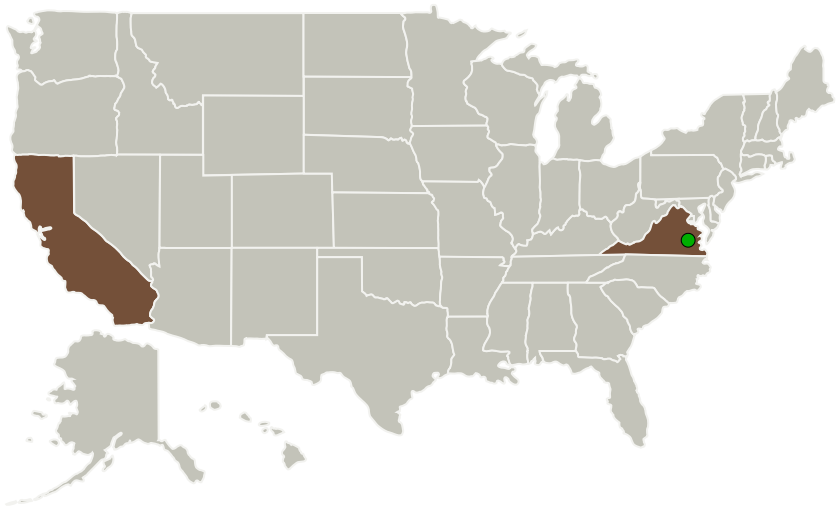
Completed Technology Project (2015 - 2015)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Ultramet	Lead Organization	Industry	Pacoima, California
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
California	Virginia

Project Transitions

June 2015: Project Start

December 2015: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/139382)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Ultramet

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

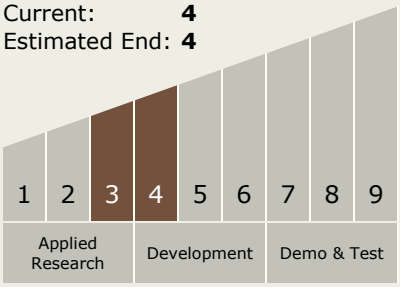
Carlos Torrez

Principal Investigator:

Timothy R Stewart

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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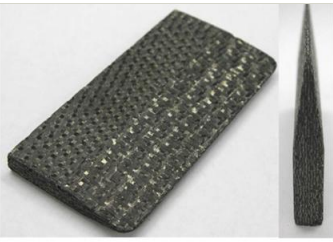
Completed Technology Project (2015 - 2015)

Images

Briefing Chart
Rapid Manufacturing of Durable, Cost-Effective Ceramic Matrix Composites for High Temperature Structures Briefing Chart *(https://techport.nasa.gov/image/133472)*



Final Summary Chart Image
Rapid Manufacturing of Durable, Cost-Effective Ceramic Matrix Composites for High Temperature Structures, Phase I Project Image *(https://techport.nasa.gov/image/135434)*

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.1 Lightweight Structural Materials

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System